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HORMONE PRIMING IMPROVES GERMINATION CHARACTERISTICS AND ENZYME ACTIVITY OF SORGHUM SEEDS (*SORGHUM BICOLOR* L.) UNDER ACCELERATED AGING

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ABSTRACT. Maximum germination percentage achieves immediately after harvesting and gradually decreases with storage time. Aging is one of the key factors in plant yield loss especially in vegetables. Seed aging is the main problem of seed storage. Application of accelerated aging treatment is used to assess seed vigor and quality. Seed priming enhances seed germination performance after aging. An experiment was conduct in order to investigate the activity of catalase and ascorbate peroxidase during accelerated aging and repair during priming treatment of sorghum seeds. In order to improve germination characteristics in aged seeds with seed priming. Our result showed that seed priming treatments significantly ($p \leq 0.01$) affected, germination percentage, germination index and means time to germination after aging (0, 3 and 6 days). Increasing aging duration resulted higher reduction in germination characteristics. Priming with gibberelic acid (GA), salicylic acid (SA) and ascorbic acid (ASC) increased germination characteristics of seed aged. The highest germination percentage, germination index, normal seedling percentage and enzyme activity were achieved in control conditions (0 day of aging). Antioxidant activity of aged seeds increased after seed priming.

Key words: Hormone priming; Seed characteristics; Enzyme activity; Accelerated aging.

INTRODUCTION

In arid regions, cereal production is widely limited by poor stand establishment (Jones and Wanbi, 1992). Particularly in drought-prone environments, cereal germination tends to be irregular and can extend over long periods (Bourgne *et al.*, 2000). Sorghum bicolor is the fourth most important world cereal grain,

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following wheat, rice, and corn. Seed quality (viability and vigor) can have a profound influence on the establishment and the yield of a crop.

Healthy plants with well-developed root systems can better withstand adverse conditions and a vigorous early seedling growth has been shown to be associated with higher yields (Harris *et al.,* 2000). Aging is manifested as reduction in germination percentage and those seeds that do germinate produce weak seedling (Veselova and Veselovsky, 2003). Seed aging is the main problem of seed storage. Unsuitable storage condition which has high temperature and moisture reduces seed vigor and viability (Sveinsdóttir *et al.,* 2009). Accelerated aging of seed is a treatment uses to assess storage quality, germination characteristics by simulation natural aging conditions for different crops (Galleschi *et al.,* 2002; Moradi *et al.,* 2009). Accelerated ageing of sunflower seeds, which consists of placing seeds at high temperature and relative humidity, is associated with a progressive decrease in seed germinability (Bailly *et al.*, 1996).

The vigor of seeds can be improved by techniques generally known as seed priming, which enhance the speed and uniformity of germination (Demir and Van De Venter, 1999). On the contrary, osmopriming of seeds of the same species, a pre-sowing hydration technique carried out by incubating seeds in a polyethylene glycol solution, improves their germination rate at suboptimal temperatures and in hypoxia (Smok *et al.*, 1993; Bailly *et al.*, 2000), and results in reinvigoration of aged seeds (Bailly *et al.*, 1998). The germination rate of aged or primed sunflower seeds has been related to the ability of antioxidant enzymes to scavenge reactive oxygen species (ROS) (Bailly *et al.*, 1998, 2000). The ROS are increase in seed ageing treatments. These ROS – superoxide radical, hydrogen peroxide and hydroxyl radical – can be produced in non-photosynthetic organs such as seeds through mitochondrial activity, if the moisture content is sufficient to enable respiration (Scandalios, 1997). In sunflower, the seed germination rate is closely correlated with CAT activity (Bailly *et al.*, 1998). Presoaking seeds with optimal concentration of phytohormones has been shown to be beneficial to growth and yield of some crop species growth under saline conditions by increasing nutrient reserves through increased physiological activities and root proliferation (Singh and Dara, 1971). Therefore, the study aimed was to determine the effect of hormone priming on germination characteristics and enzyme activity of aged of sorghum seeds.

MATERIALS AND METHODS

Seeds were incubated in closed plastic boxes for the accelerated aging treatments. Three accelerate aging regimes were performed by placing seeds at 40°C and relative humidity (RH) of 90-100 % for 0, 3 and 6 day periods.

Then seeds were divided into four other sub-samples. A sub-sample was as control (none primed) and the three other sub-samples were prepared for priming treatment. Seeds were primed with an aqueous solution of GA and SA. Treatment of GA and SA and ASC were attained at concentration of 50 ppm at 10°C for 12 h.

Standard germination test was carried out by place 50 seeds in 9 cm petri dishes at 25°C. Seeds were observed daily until day 10^{th} and germinated seeds were recorded. Investigated parameters were the germination percentage, germination index and means time to germination.

All extraction procedures were carried out at 4°C. About 0.2 gr of seed samples were homogenized with 10 ml of phosphate buffer (pH 7), followed by centrifugation of 20000 g for 15 min. The supernatants were used for determination of enzyme activity. Catalase (CAT, EC 1.11.1.6) activity was determined spectrophotometrically following H2O2 consumption at 240 nm (Bailly *et al.*, 1996). Ascorbate peroxidase (APX, EC 1.11.1.7) activity was determined according to the procedures of Al *et al.*, (1995). The activities of APX and CAT were expressed per mg protein, and one unit represented 1 μmol of substrate undergoing reaction per mg protein per min. In order to evaluated the effect of post priming on germination characteristics seeds under accelerated aging condition four factorial experiments were conducted in a completely randomized design with three replicates. Before the statistical analysis in order to unify the variance, data of percentage was subjected to data transformation (arcsine) (Ansari and Sharif-Zadeh, 2012).

Data of experiment were subjected to factorial analysis. All data were analyzed statistically by analysis of variance using MSTAT-C and Microsoft Excel software. Mean comparisons were performed using an ANOVA protected least significant difference (Duncan) ($P < 0.05$) test.

RESULTS AND DISCUSSION

Results of ANOVA analyses showed that all treatments are differ significantly ($p<0.01$) (*Table 1*). Either the interactions between some traits had significant differences.

Table 1 - Analysis of variance for interaction effects (Duration of aging × Treatment of priming) on germination percentage, germination index and mean times germination of sorghum seeds

S.O.V.	df	Germination percentage	Germination index	Mean times to germination
Treatment (A)	3	52.83**	10.71**	0.1**
Days of aging (B)	2	519.55**	103.24**	0.98**
A*B	6	7.28**	0.76**	0.006**
Error	24	1.49	0.08	0.001
CV (%)	-	1.97	2.51	0.82

**, indicate significant difference at 5%, 1% probability level, and no significantly, respectively

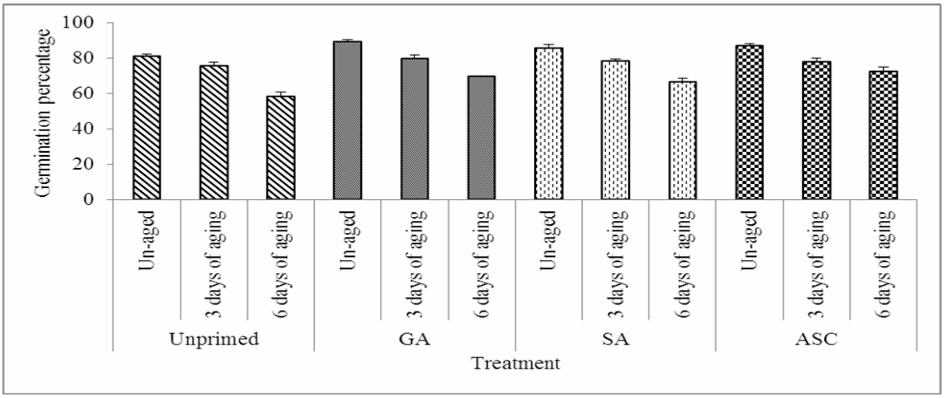

Figure 1 - Interaction effects (Duration of aging × Treatment of priming) on germination percentage of sorghum seeds

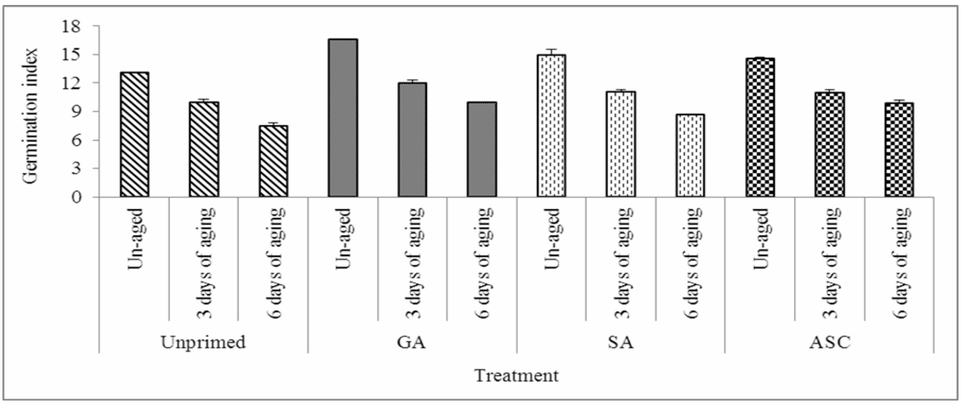

Figure 2 - Interaction effects (Duration of aging × Treatment of priming) on germination index of sorghum seeds

Interaction effects of duration of ageing and treatment of priming on seed germination percent was significantly differ and as shows in the figure (*Fig. 1*), germination percentage reduces by increasing the period of aging. Priming the aged seeds with hormones indicates that hormone priming could reduce the speed of germination percent reduction which caused by aging. As shown in the figure, the best germination percentage gained of non-aged primed seeds by GA and the lowest germination percentage gained of unprimed but aged seeds. These results are similar to Demir *et al.* (2004) on cucumber.

Interaction effects of duration of ageing and treatment of priming on seed germination index was significantly differ and as shows in the figure (*Fig. 2*), germination index reduces by increasing the period of aging. Priming the aged seeds with hormones showed that hormone priming could slowed the speed of germination index reduction which caused by aging. As shown in the figure, the best germination index gained from non-aged but primed seeds by GA and the lowest germination index gained from unprimed but aged seeds. These results are similar to Coin *et al.* (1995).

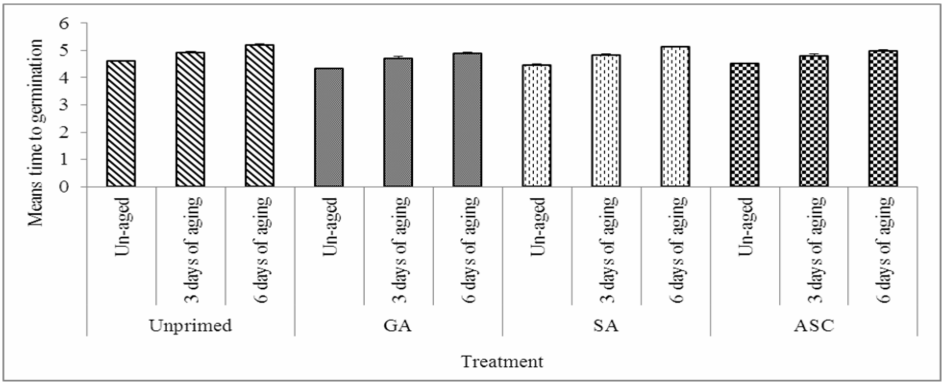

Figure 3 - Interaction effects (Duration of aging × Treatment of priming) on means time to germination of sorghum seeds

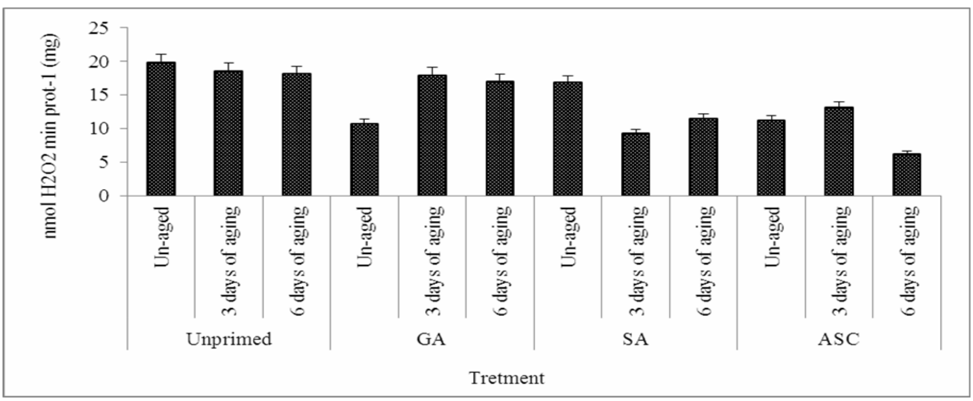

Figure 4 - Interaction effects (Duration of aging × Treatment of priming) on catalase activity of sorghum seeds

Interaction effects of duration of ageing and treatment of priming on seed means time to germination was significantly different and as shows in the figure (*Fig. 3*), means time to germination increased by increasing the period of aging. The lowest means time to germination showed in non-aged seeds which were primed with GA or SA. The most means time to germination was showed in 6 days aged seeds without any priming. Our results are supported by Ellis and Roberts (1981).

Interaction effects of duration of ageing and treatment of priming on CAT activity showed that in some cases, CAT activity increases by aging but in other ones it reduces its activity (*Fig. 4*). The lowest CAT activity gained of 6 days aged seeds which were primed with ASC, and the highest CAT activity showed in non-aged seeds which were not primed. Our results are supported by Moosavi *et al.* (2009) and Davison and Bray (1991).

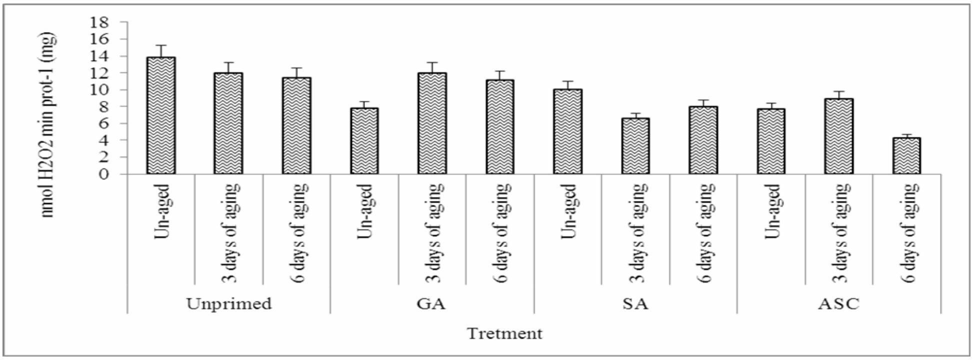

Figure 5 - Interaction effects (Duration of aging × Treatment of priming) on ascorbate peroxidase activity of sorghum seeds

Interaction effects of duration of ageing and treatment of priming on APX activity showed that in some cases, APX activity reduces by aging (*Fig. 5*). The lowest APX activity gained of 6 days aged seeds which were primed with ASC, and the highest CAT activity showed in non-aged seeds which were not primed. Our results are supported by Moosavi *et al.* (2009) and Rouhi *et al.* (2010).

CONCLUSION

Results showed that, aging reduces germination percent and germination index, but hormone primed seeds which were aged, could lower of this reduction. Priming increased antioxidant enzyme activity too and maybe, increases which were indicated in hormone primed aged seeds were affects by antioxidant activity in seeds.

REFERENCES

Ansari O., F.Sharif-Zadeh, 2012 - Osmo and hydro priming improvement germination characteristics and enzyme activity of mountain rye (*Secale montanum*) seeds under drought stress. Journal of Stress Physiology & Biochemistry, 8 (4): 253-261.

Al A., C.S.Bestwerk, B. Barna, J.W., Mansfield, 1995 - Enzymes regulation the accumulation of active oxygen species during the hypersensitive reaction of bean to *Pseudomonas syringae* pv. *phaseolicola*. Planta, 197:240-249.

Bailly C., A. Benamar, Françoise Corbineau, D. Côme, 1996 - Changes in malondialdehyde content and in superoxide dismutase, catalase and glutathione reductase activities in sunflower seeds as related to deterioration during accelerated aging. Physiologia Plantarum, 97, 104–110.

Bailly C., A. Benamar, Françoise Corbineau, D. Côme, 1998 - Free radical scavenging as affected by accelerated ageing and subsequent priming in sunflower seeds*.* Physiologia Plantarum, 104, 646–652.

Bailly C., A. Benamar, Françoise Corbineau, D. Côme, 2000 - Antioxidant systems in sunflower (*Helianthus annuus* L.) seeds as affected by priming. Seed Sci. Res., 10, 35–42.

Bourgne S., C. Job, D. Job, 2000 - Sugarbeet seed priming: solubilization of the bazic subunit of 11– S globulin in individual seeds. Seed Sci. Res., 10: 153 -161.

Coin L., M. Vaissiere, A. Noiro, A. Charrier and S. Hamon, 1995 - Comparative effects of natural and accelerate aging on barley seeds (*Hordeum vulgare* L.). Seed Sci. Technol., 23:673-688.

Davison, P.A., C.M. Bray, 1991 - Protein synthesis during osmopriming of leek (*Allium porrum*) seeds. Seed Sci. Res., 1:29-35.

Demir I., Y.S. Ozden, K. Yilmaz, 2004 - Accelerate aging test of aubergine, cucumber and melon seeds in relation to time and temperature variables. Seed Sci. Technol., 32:851-855.

Demir I., H.A Van De Venter, 1999 - The effect of priming treatments on the performance of watermelon (*Citrullus lanatus* Thunb.) Matsum & Nakai) seeds under temperature and osmotic stress. Seed Sci. Technol., 27: 871-875

Ellis R.H., E.H. Roberts, 1981 - The quantification of ageing and survival in orthodox seeds. Seed Sci. Technol., 9:373-409.

Galleschi L., A. Capocchi, S. Ghiringhelli, F. Saviozzi, L. Calucci, C. Pinzino and M. Zandomeneghi, 2002 - Antioxidants, free radicals, storage proteins and proteolytic activities in wheat (*Triticum durum*) seeds during accelerate aging. J. Agric. Food. Chem., 50:5450-5457.

Harris D., R.S. Tripathi, A. Joshi, 2000 - On-farm priming to improve crop establishment and yield in direct-seeded rice in IRRI: "Intemational Workshop on Dry–seeded Rice Technology". Bangkok, 25–28 January, 2000. The International Rice Research Institute, Manila, The Philippines, 164.

Jones M.J., A. Wanbi, 1992 - Site-factor influence on barley response to fertilizer in on-farm trials in northern Syria: descriptive and predictive models. Exp. Agric., 28: 63–87.

Moosavi S.A.., R.T. Afshari, F. Sharif-Zadeh, A. Aynehband, 2009 - Seed priming to increase salt and drought stress tolerance during germination in cultivated species of Amaranth. Seed Sci. Technol., 37:781-785.

Moradi A., Younesi O., 2009 - Effects of osmo- and hydro-priming on seed parameters of grain sorghum (*Sorghum bicolor* L.). Australian Journal of Basic and Applied Sciences, 3:1696-1700.

Rouhi H.R., K. Shakarami, R.T. Afshari, 2010 - Seed treatment to overcome dormancy of waterlily tulip (*Tulipa kaufmanniana* Regel.) AJCS, 4:718-721.

Scandalios J.G., 1997 - Oxidative stress and the molecular biology of antioxidant defenses. Cold Spring Harbor Laboratory Press, New York.

Sveinsdóttir H., F. Yan, Y. Zhu, T. Peiter-Volk, S. Schubert, 2009 -

Seed ageing-induced inhibition of germination and post-germination root growth is related to lower activity of plasma membrane H(+)-ATPase in maize roots. J. Plant Physiol., 166(2): 128-135.

Singh H., B.L. Dara, 1971 - Influence of presoaking of seeds with gibberellin and auxins on growth and yield attributes of wheat (*Triticum aestivum* L.) under high salinity, sodium adsorption ratio and boron levels. Indian J. Agric. Sci., 41: 998–1003

Smok M.A., M. Chojnowski, Françoise Corbineau, D. Côme, 1993 - Effects of osmotic treatment on sunflower seed germination in relation with temperature and oxygen. In Côme D. and Corbineau, F. (eds) Fourth International Workshop on Seeds. Basic and applied Aspects of Seed Biology, Vol. 3, ASFIS, Paris, pp. 1033–1038

Veselova T.V., V.A. Veselovasky, 2003 - Investigation of atypical germination changes during accelerated ageing of pea seeds. Seed Science and Technology, 31: 517-530.